

A REDESCRIPTION OF W. CARRUTHERS' TYPE GRAPTOLITES

By ISLES STRACHAN

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SYNOPSIS

The fourteen species of graptolites described and figured by William Carruthers, mainly in his paper of 1868, are redescribed from the type material where possible. Two neotypes are proposed. Some of the species appear to be unsatisfactory by modern standards, but it is hoped that refiguring of the types will assist future work.

I. INTRODUCTION

IN their monograph of British Graptolites (1901-18) Elles & Wood described and figured most of the previously known species as well as numerous new forms. In many cases, however, they did not use the original type material either because it was not available or because later collections had provided other, sometimes better, material. In the fifty years which have elapsed since then, discrimination of graptolite species has become keener, particularly by workers overseas who have frequently, in their subdividing, formally designated type specimens without consideration of the availability or value of the early material. It seems appropriate that the species described in the nineteenth century should be re-examined so that these workers should be able to recognize the old species accurately with the aid of modern descriptions and illustrations. The work could be tackled systematically by genus and species but this involves consideration of generic and specific limits in deciding

the scope of a paper. It is easier to treat the species for redescription by discussing one author at a time and I hope to undertake further papers of a similar scope to this.

William Carruthers (1830–1922) was born at Moffat, Dumfriesshire, and early developed an interest in the local geology, particularly in the graptolites for which the area had then recently become famous through the researches of Harkness and Salter. His own publications on graptolites are comparatively few in number but it is clear that by 1867 he was regarded as an expert on the group, since he contributed the article on graptolites to the fourth edition of Murchison's "Siluria". In the following year he described more fully the new species erected in that memoir. He strongly disagreed with Nicholson on the interpretation of a number of graptolite features and they carried on an acrimonious correspondence in the pages of the Geological Magazine during 1867. At the same time he was also describing fossil plants, to which he later devoted all his research. In 1870–72 he was assisting the young amateur John Hopkinson with his descriptions of new species of graptolites from the Moffat Shales but they both appeared to realize that the publication in 1876 of Lapworth's paper on "Scottish Monograptidae" marked a new and more critical approach to graptolite systematics and stratigraphy and neither of them published further papers on the subject. It is, however, clear from Lapworth's later papers that he maintained a friendly association with Hopkinson and Carruthers and the latter's manuscript notes on graptolites are in the Lapworth Library, Birmingham University. These notes contain no indication of how or when Lapworth acquired them but there are no references to papers after 1872 and it is possible that Carruthers gave them to Lapworth before taking up more administrative duties at the British Museum (Natural History) in 1880 and confining his research to palaeobotany.

The new species described by Carruthers are found in two main papers, in 1858 and 1868. The first of these was reprinted the following year in a more accessible journal and, as already mentioned, the 1868 paper described properly the species which were only illustrated in the appendix to "Siluria". Carruthers had some harsh remarks to make about Nicholson's drawings of graptolites and, on the whole, his own are generally sufficiently accurate to allow recognition of the type specimens. Most of these were catalogued at once in the British Museum (Natural History) collections where they can be traced. Almost all his species can be recognized fairly easily. The type of *Rastrites maximus* is the only one which has not been found and a neotype is proposed for that species.

It is a pleasure to acknowledge the ready co-operation which I have had from those at the British Museum (Natural History) who have had charge of the graptolite collections and to thank their photographers who have provided most of the illustrations for the plates. I must also express my thanks to the Geological Survey & Museum and to the Royal Scottish Museum for the loan of specimens over a period which has been much longer than I had at first intended.

Specimens with Q numbers are in the British Museum (Natural History); with GSM, in the Institute of Geological Sciences, London; with BU, in the Geology Department, University of Birmingham; and with SM, in the Sedgwick Museum, Cambridge.

II. DESCRIPTIONS

Leptograptus capillaris (Carruthers)

Pl. 1

- 1868 *Cladograptus capillaris* Carruthers: 130, pl. 5, figs. 7, 7a.
1876 *Leptograptus capillaris* (Carr.) Lapworth: 9, pl. 3, fig. 72.
1903 *Leptograptus capillaris* (Carr.); Elles and Wood: 112, pl. XV, figs. 4a-d.
?1954 *Leptograptus capillaris* (Carr.); Sherrard: 95, pl. 11, fig. 8.

Original description. "Extremely slender polypary, with remote branches and very minute hydrothecae; about twenty-four in an inch. It is not so abundant as *C. linearis*, and is easily distinguished by its capillary appearance. It is probably the same species as that figured and described by Emmons in his American Geology, vol. i, p. 109, pl. 1, fig. 7, under the name of *Nemagraptus capillaris*. Loc. Moffat".

Comments on usage. There appears to have been little confusion over this species. Although he quoted Emmons' species, Carruthers clearly intended his own form to rank as a new species and the American form is now referred to *Thamnograptus*. The original description refers to "remote branches" which are not shown by the type specimens or original figure but one illustration of *Cladograptus linearis* of the previous year (Carruthers 1867, pl. 2, fig. 17a) shows the characteristic curved stipes with secondary branches. The original of this has not however been recognized.

TYPE MATERIAL. The syntypes, British Museum (Natural History) Q.30, were refigured by Elles & Wood. As lectotype I select the large rhabdosome on the upper right of Carruthers' original figure (see Pl. 1, fig. 2). The precise locality and horizon are not known but Elles & Wood give it as Hartfell Spa?, Hartfell Shales.

DIAGNOSIS. Very slender *Leptograptus* with markedly curved stipes, maximum breadth 0.5 mm. thecae eight to ten per cm.

REVISED DESCRIPTION. The species normally occurs crowded on the slabs so that details of the stipes are not readily seen. The sicula is inconspicuous but the stipes appear to grow initially horizontally or even somewhat downward before curving gracefully upwards and inwards, forming loops on occasion. The stipes widen from an initial breadth of 0.2 mm. to a maximum of 0.5 mm. over a distance of at least 4 or 5 cm. and appear to be twisted so that the thecae can appear on either side of the curve. The sicula is 2 mm. long and about 0.2 mm. wide but details of the origin of the stipes are not known. The thecae appear to be simple leptograptid tubes but the preservation of the distal parts of the stipes is such as to make measurements of their length and overlap impossible.

GEOLOGICAL HORIZON. Lapworth (1878) recorded the species only from the zone of *Pleurograptus linearis* but Elles & Wood (1903) also recorded it from the zone of *Dicranograptus clingani*. The type slab shows no associates, nor do most of the specimens in the Lapworth Collection. Lithologically, however, the slabs agree with the upper part of the Lower Hartfell Shales.

DISTRIBUTION. This species is known from only a few localities in the South of Scotland and is not recorded from beds of a similar age in South Wales. Ruedemann

and Decker recorded it from the Viola Limestone in Oklahoma but gave no figures (Ruedemann 1947). Sherrard (1954) recorded it from New South Wales but her figure shows stipes which appear to be too broad and not curved enough. They may be one of the forms of *Leptograptus flaccidus* which occurs about the same horizon, e.g. *L.f. arcuatus* Elles & Wood. Thomas (1960) illustrated a form which is clearly not *L. capillaris* as the stipes are too straight, and this then casts doubt on the range of the species as given by Thomas, which goes up to the Ashgill Series.

***Pleurograptus linearis* (Carruthers)**

Pl. 2; Figs. 1a-c

- 1858 *Cladograptus linearis* Carruthers : 467, fig. 1.
- 1859 *Cladograptus linearis* Carruthers : 24, fig. 1.
- non 1867 *Cladograptus linearis* Carruthers; Carruthers : 369, pl. 2, fig. 17.
- ?1867a *Cladograptus linearis* Carruthers; Carruthers : 540, fig. 8.
- 1867 *Pleurograptus linearis* (Carruthers) Nicholson : 257, pl. 11, figs. 1-5.
- 1868 *Cladograptus linearis* Carruthers; Carruthers : 129.
- 1876 *Pleurograptus linearis* (Carruthers); Lapworth, pl. 3, fig. 69.
- 1904 *Pleurograptus linearis* (Carruthers); Elles & Wood : 119, pl. 16, fig. 7, pl. 17, fig. 1.

ORIGINAL DESCRIPTION. "From a short and very slender base the zoophyte divides into two stems, each supporting the cells on their upper sides. Branches are given off at irregular intervals from these principal stems. The length of the polypidom is very great; one specimen I have been able to trace for nearly three feet . . . The polypidom at its origin, near to the slender base, is very narrow, being little more than a fine line; as it increases in length it increases in breadth, until it is fully two-fifths of a line broad. The cells are very remote from each other, and are, at first sight, from the slight indentation they make in the stem, scarcely perceptible, giving the Graptolite the appearance as if it were a clear line. The mouth of the cell is straight and at right angles to the axis; it makes an indentation equal to about one-sixth of the breadth of the polypidom. The number of cells in an inch is about eighteen. Type locality Hartfell."

COMMENTS ON USAGE. Carruthers' later figures (?1867, 1867a) are different from his original but there has been no difficulty in the recognition of his species. Carruthers accepted Nicholson's specimen of *Pleurograptus linearis* although he was very critical of the detail of the figures. Nicholson's specimen was refigured by Elles & Wood who also figured a variety *simplex* in which the branches are much more widely spaced.

TYPE MATERIAL. Carruthers' original specimen is in the British Museum (Natural History), Q.848, and the counterpart is amongst material presented to the Royal Scottish Museum, Edinburgh, by Carruthers in 1858 (RSM 1858.10.4). Nicholson's specimen, Q.27, was said by Elles & Wood to be the type specimen but it is clearly not. The lower of the two large specimens on the type slab has four lateral branches and is recognizable as the specimen figured in 1858 (see Pl. 2, figs. 1, 2).

REVISED DESCRIPTION. Rhabdosome consisting of two or three main stipes arising from the sicula with secondary branching on one or both sides. Stipes up

to 1 mm. broad; thecae simple leptograptid, about eight per cm., with apertural excavations occupying about one-third of the rhabdosome breadth. The sicula is not seen on any of the figured material and is probably associated in older rhabdosomes with one of the branches, a feature also seen in species of *Leptograptus* where a third branch may be developed. Young specimens on the type slab, however, suggest that the sicula is about 2 mm. long. The stipes are initially very slender but show some secondary thickening in older specimens where the thecae on the main stipes are difficult to distinguish. There is considerable variation in the branching, Nicholson's specimen (Pl. 2, fig. 3) being much stiffer than Carruthers' or the other specimen figured by Elles & Wood in which the tertiary branched stipes are aligned in flowing curves. This suggests that the variation in attitude of the stipes is simply a depositional effect.

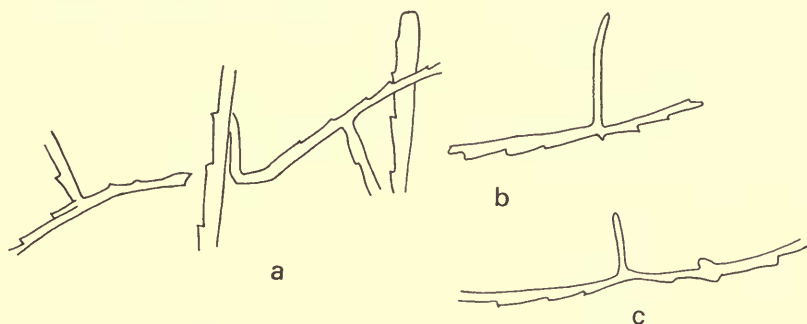


FIG. 1. *Pleurograptus linearis* Carr. a. Enlargement of proximal part of main stipe showing 2 lateral branches and possible central branch from the sicula. Counterpart of type slab, R.S.M. 1858.10.4. The 2 parallel distal parts of branches are the left hand pair from the holotype (Pl. 2, fig. 1). b, c. Young specimens showing sicula, type slab, Q.848. All $\times 5$.

DISTRIBUTION. *P. linearis* appears to be confined to the one horizon in the south of Scotland where, however, it is quite common if all the fragments showing this type of branching really belong to it. Ruedemann (1908; 1947) figured a single specimen from the Utica Shale of New York State which shows similar branching at rather more distant intervals, approximating in that respect to var. *simplex* which is also recorded by Thomas (1960) from Australia.

Dicellograptus elegans (Carruthers)

Pl. 3, fig. 1.; Figs 2a, b.

- 1867 *Didymograptus elegans* Carruthers : 369, pl. 2, fig. 16a.
- 1868 *Didymograptus elegans* Carruthers; Carruthers : 129, pl. 5, figs. 8a, ?d.
- 1871 *Dicellograptus elegans* (Carruthers) Hopkinson : 24, pl. 1, fig. 3.
- 1876 *Dicellograptus elegans* (Carruthers); Lapworth, pl. 4, fig. 87.
- 1877 *Dicellograptus elegans* (Carruthers); Lapworth : 141, pl. 7, fig. 8.
- 1904 *Dicellograptus elegans* (Carruthers); Elles & Wood : 159, pl. 23, figs. 2a-e.
- ?1947 *Dicellograptus elegans* (Carruthers); Ruedemann : 380, pl. 63, fig. 1.
- 1954 *Dicellograptus elegans* (Carruthers); Sherrard, pl. 10, fig. 6.

ORIGINAL DESCRIPTION. "Branches of the polypary divaricating at various angles, and with a slight curve within a short distance of the proximal origin of the

polyvary. The hydrothecae are rounded at the apex, and free throughout a considerable portion of their length and the intervening spaces are rounded at the base; about twenty-two cells in an inch. The initial process is obvious in young specimens, but I have not been able to detect it in old individuals; the outer apex of the angle ornamented with three short strong spines. Loc. Moffat''.

COMMENTS ON USAGE. Since Elles & Wood refigured the type specimen there has been no difficulty with this species. The originals of Carruthers' figures 8b and 8c (BM(NH) Q.54) were recognized by Hopkinson (1871) as being a distinct species (*D. morrisii* Hopkinson) and not merely young stages of *elegans* as Carruthers thought.

TYPE MATERIAL. The holotype, Q.850 (Pl. 3, fig. 1), is from the Hartfell Shales, Dobbs Linn. The species appears to be commonest in the *P. linearis* Zone but the associates on the type slab (*Dicellograptus pumilus* and *Climacograptus* spp.) give no direct confirmation of horizon.

DIAGNOSIS. *Dicellograptus* with markedly introverted thecae and with distinct sigmoid curvature of stipes near proximal end, so that the stipes curve first upwards, then outwards, then upwards again.

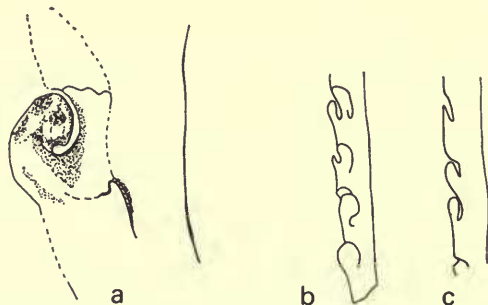


FIG. 2. *Dicellograptus* spp. a. *D. elegans* Carr. Detail of thecal aperture in proximal part of stipe. Q.850. $\times 30$. b. *D. elegans* Carr. Distal thecae. Q.850. $\times 5$. c. *D. moffatensis* Carr. Distal thecae. Q.843. $\times 5$.

REVISED DESCRIPTION. The proximal double curvature is quite distinctive and the stipes have an almost uniform width of 1 mm. throughout their length. The first two thecae have prominent apertural spines which, with the virgella, give the three-spined proximal end noted by Carruthers. The thecae number eight to ten per cm. and are of the strongly introverted type with marked ventral curvature (group IV of Elles & Wood, which however are not introverted, see Bulman 1944 : 37).

GEOLOGICAL HORIZON. Lapworth (1878) and Elles & Wood (1904) recorded the species only from the *P. linearis* zone, but in the summary range chart at the end of the Monograph, Elles & Wood also recorded it as common in the underlying zone of *D. clingani*. Elles (1925) also recorded it from both zones so its precise range must await a revision of the Hartfell Shales. Foreign records are surprisingly scanty but it seems to occur in Australia at the same horizon.

Dicellograptus moffatensis (Carruthers)

Pl. 3, figs. 5, 6; Fig. 2c

- 1858 *Didymograpsus Moffatensis* Carruthers : 469, fig. 3.
 1859 *Didymograpsus Moffatensis* Carruthers; Carruthers : 26, fig. 3.
 1868 *Didymograpsus Moffatensis* Carruthers; Carruthers : 129.
 1871 *Dicellograptus Moffatensis* (Carruthers) Hopkinson : 25, pl. 1, fig. 4.
 1875 *Dicellograptus moffatensis* (Carruthers); Hopkinson & Lapworth : 654, pl. 34, fig. 5a.
 1877 *Dicellograptus Moffatensis* (Carruthers); Lapworth : 141, pl. 7, fig. 9.
 1904 *Dicellograptus moffatensis* (Carruthers); Elles & Wood : 157, pl. 23, figs. 1a-f.

ORIGINAL DESCRIPTION. "The base terminates in three distinct spinous processes. The zoophyte bifurcates from the base. The general appearance is like the figure; or occasionally the lines form an acute angle for about a quarter of an inch, then suddenly expand in slight curves, almost at right angles, for a short distance, when they again recur to their original direction. The branches are united for about a quarter of a line by a slight web, which in some specimens is terminated in a fine process of short length, taking the direction of a line bisecting the angle. The cells are arranged in the outer margins; they are very remote, and penetrate the polypidom to scarcely one-fourth of its breadth; they form slight openings on the margin of the polypidom, first entering at a right angle, and then suddenly turning downwards. These openings are lengthened ovate pouches, answering exactly in shape and size to the cell-serratures of the margin. The number of cells in an inch is about twenty. The breadth of the polypidom is about two-thirds of a line. Type locality Hartfell."

COMMENTS ON USAGE. In 1868, Carruthers noted *D. divaricatus* (Hall) and *D. anceps* (Nicholson) as synonyms of his own species but this is merely a reflection of the confused state of graptolite systematics at the time. Elles & Wood refigured Carruthers' type but the species does not seem to have been widely recognized.

TYPE MATERIAL. This is one of the few species of which Elles & Wood made any discussion of type specimens. They considered that Carruthers' specimen was not a satisfactory type and that a specimen from the Lapworth Collection should be taken as the type. Carruthers' original figure is admittedly poor (Pl. 3, fig. 5) but the type slab shows three specimens which agree fairly well with it and show the essential characters of the species. The abrupt widening of the stipes on Lapworth's specimen, which Elles & Wood wanted as a character of the species, appears to be the result of slight shearing.

It is impossible to decide which of the three specimens was the original of Carruthers' figure so the specimen (Q.843) figured by Elles & Wood is here selected as lectotype (see Pl. 3, fig. 6). It is from the Hartfell Shales of Hartfell and is associated on the slab with *Orthograptus* cf. *whitfieldi*. This probably indicates a low horizon in the Hartfell Shales. Lapworth (1878) records it no higher than the zone of *Climacograptus wilsoni*.

REVISED DESCRIPTION. Stipes sub-parallel initially, then diverging making an angle of about 45°, sometimes later converging. Stipes widening from an initial breadth of 0.4 mm. to a maximum of about 1.5 mm. Thecae eight to ten per cm.,

with markedly curved ventral walls and introverted apertures. The proximal end usually shows a membrane in the axil of the stipes, obscuring the sicula. The virgella and first thecal spines variably developed. The thecae are poorly preserved but distally appear to be very similar to those of *D. elegans* (Fig. 2c).

It is unfortunate that both Carruthers and Hopkinson included *D. divaricatus* (Hall) in their synonymy of this species as it makes it difficult to establish what they regarded as the diagnostic features of the species. The general shape of the rhabdosome appears to be the most characteristic feature, particularly the narrow axil and later divergence. In this respect the specimen figured by Elles & Wood in their Monograph (pl. 23, fig. 1c) is not at all typical but its only associates are the pair of specimens figured on the same plate (pl. 23 fig. 1b) which have the typical shape. As the rhabdosomes were flexible in life to some extent, this poses the problem of how much reliance should be placed on rhabdosome shape as a specific character in *Dicellograptus* and other forms with long slender stipes. *D. moffatensis* can be readily separated from other British *Dicellograptus* by size and shape of rhabdosome, *D. morrisii* Hopkinson being the most similar but with a more open axil. *D. moffatensis* var. *alabamensis* Ruedemann 1908 is not related at all and is clearly a *Dicranograptus*, close to *D. brevicaulis* Elles & Wood 1904.

DISTRIBUTION. Elles & Wood recorded the species widely throughout the British Isles but it seems doubtful now if it occurs in the Lake District. The specimen figured by Hopkinson & Lapworth from Llanvirn (SM. A17400) is a poorly-preserved, bent dichograptid (O. M. B. Bulman, personal communication). The specimen from Abereiddy Bay refigured by Elles & Wood may well come from the locality referred to the "Dicranograptus Shales" (Cox, 1915 : 304) and not from the *D. murchisoni* Shales for which the area is best known. If this is so, the species ranges from ?Llandeilo Series to Caradoc Series (*wilsoni* Zone). It has been recorded from Australia but Thomas (1960) does not list it in his range chart and so presumably does not consider it to be present. Linnarsson recorded it from Scania but Hadding (1913) transferred this form to his new species *D. vagus*.

Dicranograptus clingani Carruthers

Pl. 3, figs. 2-4; Fig. 3a

- 1868 *Dicranograptus Clingani* Carruthers : 132, pl. 5, figs. 6a-c.
- 1870 *Dicranograptus Clingani* Carruthers; Hopkinson : 358, pl. 16, figs. 4a-c.
- 1876 *Dicranograptus Clingani* Carruthers; Lapworth, pl. 3, fig. 76.
- 1877 *Dicranograptus Clingani* Carruthers; Lapworth : 141, pl. 6, fig. 43.
- 1904 *Dicranograptus Clingani* Carruthers; Elles & Wood : 165, pl. 24, figs. 1a-i.
- 1915 *Dicranograptus Clingani* Carruthers; Hadding : 22, pl. 3, figs. 1-8.

ORIGINAL DESCRIPTION. "Polypary with a short diprionidian portion, the proximal end furnished with three very delicate spines; hydrothecae forming a slight serration along the margin; twenty-one cells in the inch. Loc. Moffat."

COMMENTS ON USAGE. Elles & Wood put this species in a group by itself on the basis of the thecal characters—approximately straight ventral walls and horizontal

apertures. These characters are clearly seen in Hopkinson's figures and serve to differentiate the species from other forms with a short biserial portion.

TYPE MATERIAL. Elles & Wood refigured as "type specimen" the original of Carruthers' fig. 6a and this can be taken as a designation of a lectotype. The specimen, Q.55 (Pl. 3, figs. 3, 4), is from the Hartfell Shales, Hartfell Spa. Carruthers' fig. 6b, Q.842 (Pl. 3, fig. 2), is also from this locality.

REVISED DESCRIPTION. *Dicranograptus* with short biserial portion consisting of three or four pairs of thecae, and short, straight uniserial stipes diverging at about 40° . The biserial portion has a uniform breadth of about 1 mm. and the branches are similarly uniform at about 0.8 mm. The virgella is usually prominent as a short spine and the first two thecae may have sub-apertural spines. The ventral walls of the later thecae are straight and the apertures are horizontal in excavations which occupy about one-third of the breadth. The uniserial stipes appear to be rarely more than 2 cm. long although Hadding figures a specimen with stipes nearly 4 cm. long. The distal thecae number eight to ten per cm. but the stipes are usually twisted so that the thecae are in scalariform view (Fig. 3a) and it is difficult to decide the precise thecal shape. The apertural excavations are clearly marked by lists and it is probable that the straight ventral walls of the proximal thecae continue in the distal ones.

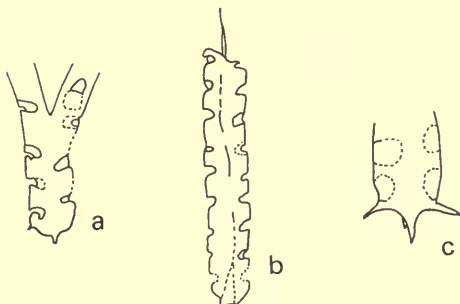


FIG. 3. a. *Dicranograptus clingani* Carr. Proximal end of paratype. Q.842. $\times 5$. The right hand side of the specimen is poorly preserved. b. *Climacograptus minutus* Carr. Lectotype. Q80. $\times 5$. c. *Cryptograptus tricornis* Carr. Proximal end of lectotype showing basal spines. Q1299. $\times 5$.

DISTRIBUTION. The species is common in the Lower Hartfell Shales of the Moffat area and is also found at Conway. Elles & Wood recorded it from equivalent beds in Ireland. It is found in Scandinavia but has not been recorded from North America. Thomas (1960) gives records but omits it from his range chart, so casting doubt on the records. The type specimen has no associates but Elles & Wood recorded it only from its own zonal association.

Climacograptus minimus (Carruthers)

Pl. 4, fig. 3; Fig. 4c

1868 *Diplograptus minimus* Carruthers : 74, 130, pl. 5, figs. 12a, b.

?1906 *Climacograptus minimus* (Carruthers) Elles & Wood : 191, pl. 27, figs. 1a-g.

ORIGINAL DESCRIPTION. "This agrees with *D. pristis* in general appearance, and in the form and arrangement of the cells, except that the whole polypary and all its parts are so very small. Had I met with only a few specimens, I would have considered it as merely an accidental variety, but I have seen so many, all agreeing in size, that I cannot doubt that it is a good species, especially as young specimens of *D. pristis* early attain their full breadth, and the increase of the polypary is by addition to its distal end, and not to the size of the already formed hydrothecae, just as in the living *Sertulariadae*. About thirty-eight cells to one inch. Loc. Moffat."

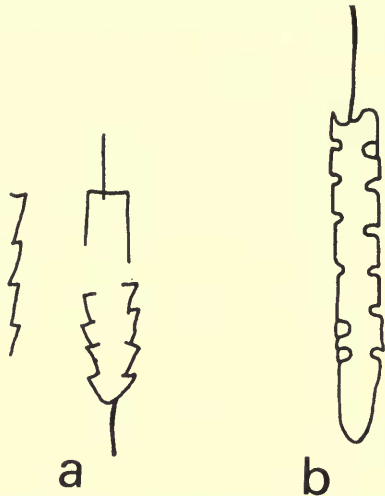


FIG. 4. Figures to show Carruthers' clear distinction between his two small species of diplograptid. a, Copy of original MS drawing of "*Diplograptus minimus*" which has appended note "38 to an inch". b, Similar copy of *Climacograptus minutus* which has notes "32 to 40 to an inch, nearly opposite".

COMMENTS ON USAGE. In his 1868 paper, Carruthers clearly distinguished two small biserial species and Fig. 4, taken from his notebook, illustrates his ideas of the differences, one clearly climacograptid, the other what he called diplograptid (now orthograptid). His type slab however shows a large number of small, poorly-preserved rhabdosomes which appear to be almost all climacograptid and Elles & Wood certainly regarded his species in this light. In his description of the species (1868 : 130) he called it *Diplograptus minutus* although elsewhere, in the explanation of the plate published in the first part of the paper (1868 : 74), he called it *D. minimus*, agreeing with his MS notes, and usage of this prior name avoids the homonym which results from the transference of the species to *Climacograptus*.

Elles & Wood did not re-figure Carruthers' material, and their specimens, from the Hartfell Shales (*clingani* and *linearis* Zones), reach a breadth of 2 mm. Carruthers' specimens on the type slab are only about 1 mm. wide and are associated with some slender uniserial stipes, which look very like *Monograptus* sp. (*atavus* or *acinaces* type). It thus seems probable that Elles & Wood's species is not the same as Carruthers' but it is clear from the foreign references (e.g. Ross & Berry 1963, Obyt & Sobolevskaya 1964) that it is Elles & Wood's species which is nowadays

recognized under this name. Carruthers' original notes are of little use since the only measurements he gives are the thecal numbers per inch. A sketch of "*Diplogr. minimus*" clearly shows thecae of an orthograptid type in accordance with his comparison of it with *D. pristis* but, as mentioned above, the common form on the type slab appears to have climacograptid thecae. The species must remain for the moment in an unsatisfactory state since a proper appraisal of Elles & Wood's form must await critical re-examination of the Upper Ordovician climacograptids.

TYPE MATERIAL. Q.82, a slab crowded with poorly-preserved specimens.

REVISED DESCRIPTION. The rhabdosome is about 1 mm. wide and up to 10 mm. long. Thecal details are obscure.

HORIZON. As noted above, the type slab shows slender uniserial stipes very similar to monograptids of the *vesiculosus* and *cyphus* Zones, in contrast with the description by Elles & Wood of the species from the Hartfell Shales (*clingani* and *linearis* Zones).

Climacograptus minutus Carruthers

Pl. 4, fig. 1, ; Figs 3b, 4b

1868 *Climacograptus minutus* Carruthers : 132, pl. 5, fig. 10a.

?1906 *Climacograptus minutus* Carruthers; Elles & Wood : 211, pl. 27, figs. 12a-c.

ORIGINAL DESCRIPTION. "This is a very minute but well-marked species, never attaining a greater size than represented on the Plate. There are at the rate of from thirty-two to forty cells in the space of an inch. Loc. Moffat."

COMMENTS ON USAGE. This species does not seem to have been widely recorded, probably because of its unsatisfactory nature. Carruthers' original specimens are of widely differing widths and Elles & Wood based their account of the species on other material from the British Museum (Natural History). Packham (1962) revised some of the British Silurian diplograptids but did not discuss this species. His *C. tangshanensis linearis* appears to be close to Carruthers' fig. 10b (1868).

TYPE MATERIAL. Carruthers' original specimens can be recognized and appear to be of two different forms. His fig. 10a (Q.80) is here selected as lectotype (Pl. 4, fig. 1). The original of fig. 10b (Q.1372) is a narrower form and fits well with *Climacograptus scalaris miserabilis* Elles & Wood. Elles & Wood's figured material (Q.849) is all somewhat distorted and it is clear that they did not use Carruthers' original specimens for their description, probably through some confusion with "*Diplograptus minutus*".

REVISED DESCRIPTION. Rhabdosome 7 mm. long. 1.2 mm. broad; thecae thirteen per cm., with large excavations occupying about one quarter of the breadth of the rhabdosome and about equal to the length of the free ventral wall. The apertures are nearly opposite each other (as recorded in Carruthers' notes) and not alternate as stated by Elles & Wood. The proximal end of the type specimen is poorly preserved but there appears to be a stout virgula which is prolonged beyond the distal end of the rhabdosome. The type specimen is completely flattened and it is not possible to make out any details of a median septum.

The uniform breadth of the rhabdosome and the large opposite excavations combine to make this form quite distinct from other British climacograptids. Unfortunately the range of variation is not known and since the type specimen has no associates, its precise horizon is also doubtful. It remains therefore an unsatisfactory species.

Cryptograptus tricornis (Carruthers)

Pl. 4, figs. 4-6; Fig. 3c

- 1858 *Diplograpsus tricornis* Carruthers : 468, fig. 2.
- 1859 *Diplograpsus tricornis* Carruthers; Carruthers : 25, fig. 2.
- 1867 *Diplograpsus tricornis* Carruthers; Carruthers : 290, pl. 1, figs. 10a-d.
- 1868 *Diplograpsus tricornis* Carruthers; Carruthers : 131, pl. 5, fig. 11a, b.
- 1880 *Cryptograptus tricornis* (Carruthers) Lapworth : 171, pl. 5, figs. 27a-e.
- 1908 *Cryptograptus tricornis* (Carruthers); Elles & Wood : 296, pl. 32, figs. 12a-d.
- 1908 *Cryptograptus tricornis* (Carruthers); Ruedemann : 443, pl. 28, figs. 1-4.
- 1913 *Cryptograptus tricornis* (Carruthers); Hadding : 40, pl. 2, figs. 13-14.
- 1915 *Cryptograptus tricornis* (Carruthers); Hadding : 325, pl. 6, fig. 15.
- 1934 *Cryptograptus tricornis* (Carruthers); Hsu : 87, pl. 6, figs. 13a-m.
- 1937 *Cryptograptus tricornis* (Carruthers); Bulman : 5, t-fig. 8.
- 1945 *Cryptograptus tricornis* (Carruthers); Bulman : 29, pl. 2, figs. 1-8.
- 1960 *Cryptograptus tricornis* (Carruthers); Thomas, pl. 6, fig. 69.

ORIGINAL DESCRIPTION. " This species can be readily distinguished by the three spines which adorn its base, and which are almost always preserved. The central spine is a continuation of the line of the axis; it is shorter than the lateral ones . . . The polypidom is more slender than in *D. foliaceus*, which in general outline it somewhat resembles. The axis is slender, and produced beyond the other parts of the fossil. The cell-walls are well marked, extending upwards from the axis to the boundary of the fossil. Each cell forms a rhomb whose outer border is slightly indented, giving the boundary of the fossil a faintly serrated aspect. When the fossil is preserved so as to show the serratures, the spines are so compressed that the central one is almost or altogether lost. When the spines are well preserved and in the position described, no traces of the individual cells are discernible; the boundary of the fossil is an unbroken line ".

In 1868, Carruthers added " When I described this species I had not detected the mouths of the cells in those specimens in which they should have been shown on the upper surface. In more perfectly preserved specimens since obtained these have been beautifully shown ".

COMMENTS ON USAGE. This species has been widely recognized as it is easily identified from the original description and figures. Lapworth (1880) discussed the varying appearance of the thecae at some length and introduced the genus *Cryptograptus* for this and allied species. Hadding (1915) showed by comparison with *Glossograptus* that the two stipes were in lateral contact (the monopleural arrangement of Jaanusson 1960) and removed the genus from the Diplograptidae. The structure of the proximal end was not, however, elucidated until 1938 when Bulman described isolated specimens from the Balclatchie Limestone and the two different

aspects of the basal spines noted by Carruthers was explained. A number of varieties have been described, differing mainly in the breadth of the rhabdosome.

DIAGNOSIS. Rhabdosome biserial, monopleural, 2–4 cm. long widest at base when preserved in lateral view, maximum width 1.8 mm. but typically narrower. Thecae ten to twelve per cm. Basal spines conspicuous, but short.

TYPE MATERIAL. BM(NH) Q. 1299, presented to the museum in 1860, is almost certainly Carruthers' original slab. It is crowded with specimens up to 35 mm. long and 1.6 mm. broad but it is not possible to recognize the original figured specimens. Accordingly, one of the better specimens has been selected as lectotype (Pl. 4, fig. 4). The association on the slab includes abundant *Corynoides calicularis* Nich. Similar pieces in the Lapworth Collection (Birmingham University) are labelled "The Cornice, Hartfell" and, although this is not marked on Lapworth's published map of Hartfell, it would appear from the text that the horizon is lowest Hartfell, zone of *Climacograptus wilsoni*.

DESCRIPTION. No detailed description is needed since that in the Monograph is satisfactory and has been recently supplemented by Bulman's detailed account of isolated specimens. There seems to be some variation in the thecal count, specimens from Girvan having consistently higher (twelve to sixteen per cm.) counts. Elles & Wood described the variety *schaeferi* which Lapworth had figured earlier and claimed that it was "somewhat wider than the typical form". Examination of the material in Lapworth's collection does not confirm this difference but there seems to be a difference in thecal shape and the basal spines are not conspicuous.

DISTRIBUTION. This species has been recorded from all continents and some of the more recent records are given in the synonymy. The stratigraphic range was given by Elles & Wood as Arenig Series (*extensus* Zone) to Caradoc Series (*clingani* Zone), a longer range than any other Ordovician species, and it is possible that critical examination of a large number of specimens from the lower horizons might show them to be distinct from the typical form from the early Caradoc. Sherrard (1954) records it from the zone of *P. linearis* but no illustration is given to confirm this.

Monograptus clingani (Carruthers)

Pl. 5, figs. 1–5

- 1867 *Graptolithus Clingani* Carruthers : 369, pl. 2, fig. 8.
- 1868 *Graptolithus Clingani* Carruthers; Carruthers : 127, pl. 5, figs. 19a, b.
- 1876 *Monograptus Clingani* (Carruthers); Lapworth, pl. 1, fig. 24.
- 1876a *Monograptus Clingani* (Carruthers); Lapworth : 501, pl. 20, figs. 3a–c.
- non 1897 *Monograptus Clingani* (Carruthers); Perner, pl. 11, figs. 15–17.
- 1913 *Monograptus Clingani* (Carruthers); Elles & Wood : 463, pl. 46, figs. 11a–f.
- 1951 *Monograptus clingani* (Carruthers); Bulman : 322, t-fig. 5.
- 1956 *Monograptus clingani* (Carruthers); Bondarenko & Keller : 91, t-fig. 2.

ORIGINAL DESCRIPTIONS. 1867. ". . . a beautiful small species, which at first I referred to *G. millepeda*, M'Coy, but that species is certainly the proximal end of *G. Becki*, and this differs from it in having a very broad common base, from which the hydrothecae rise." 1868. "Polypary, small and arcuate, with a broad common

canal, and slender somewhat recurved hydrothecae. This beautiful little graptolite I long supposed to be only the proximal portion of some other species, but the large number I have met with, all equally perfect, none larger than fig. 19a, and many showing the prolongation of the axis beyond the distal end, together with the great breadth of the common canal (forming two-thirds of the breadth of the whole polypary), unlike the early portion or proximal fragment of any graptolite with which I am acquainted, have induced me to consider it a good species . . ."

COMMENTS ON USAGE. Carruthers' descriptions gave no real details of the species. From the syntypes it appears that two different species may be confused but as both are young rhabdosomes it is not possible to be sure. The characters of the proximal thecae are not determinable from the lectotype, chosen by Přibyl (1948), which is completely flattened but they appear to be of the *priodon* type with well marked hooks to the apertures (Pl. 5, fig. 5). The distal thecae are similar. Lapworth recorded a "Clingani Band", some 6 inches thick, in his Dobbs Linn sections and numerous specimens in his collection bear this label. In a recent resurvey of the section, Toghill (1965) recognized the unit again but recorded *M. clingani* from a wider horizon.

TYPE MATERIAL. The specimen (Q.87) figured by Carruthers as fig. 19a was referred to as "type specimen" by Elles & Wood in the explanation of their plate and the second specimen called "co-type" (Q.84), leaving them perhaps of equal status. Přibyl (1948) however clearly stated that Carruthers' fig. 19a is the lectotype which is unfortunate as this specimen has a broader common canal than in most of the other specimens referred to the species. This may be only a preservational feature as specimens in the Lapworth collection from Duffkinnel, the type locality, are all of the common type in which the hooks occupy at least half of the breadth of the rhabdosome.

REVISED DESCRIPTION. Rhabdosome dorsally curved at the proximal end, distally becoming more or less straight; widening from an initial breadth of 0.6 mm. to a maximum of about 1.5 mm. within the first 6 or 7 mm. The thecae are of *priodon* type with about one-third of the length involved in the hook which occupies half of the breadth of the stipe. The shape of the thecae varies a good deal with the type of preservation but there appears to be no overlap of the thecae (Bulman 1951, fig. 5), the broad prothecal portion occupying the whole of the breadth of the rhabdosome.

DISTRIBUTION. Lapworth recorded the species in abundance from a 6-inch band within the *sedgwickii* Zone at Dobbs Linn, and Marr & Nicholson (1888) similarly had a *M. clingani* Band above their *convolutus* Zone in the Lake District. Elles & Wood apparently extended the *convolutus* Zone to include these horizons and also recorded the species from the *gregarius* Zone below in their summary table.

Monograptus intermedius (Carruthers)

Pl. 5, fig. 6; Fig. 5

1868 *Graptolithus intermedius* Carruthers : 126, pl. 5, fig. 18.

?1876a *Monograptus intermedius* (Carruthers) Lapworth : 316, pl. 10, figs. 10a, d.

non 1913 *Monograptus intermedius* (Carruthers); Elles & Wood : 485, pl. 49, figs. 3a-c.
 ?1952 *Spirograptus intermedius* (Carruthers); Münch, pl. 37b, figs. 7a, b.

ORIGINAL DESCRIPTION. " Polypary slender; proximal end composed of a slender canal with distant, isolated, and very small hydrothecae; adult hydrothecae, short, triangular, the upper margin of the cell forming an acute angle with the common canal. About twenty-six cells to an inch. This species differs from *G. Nilssoni*, *G. tenuis* and *G. Hisingeri* in the form of the cells, and from the last also in the slender common canal. Perhaps Portlock's figure 6a. pl. 19 of his Report belongs to this species. Loc. Moffat. "

COMMENTS ON USAGE. It is clear from the specimens in Lapworth's collection that he included under this name a number of slender forms which do not agree with Carruthers' type specimen. Elles & Wood used only one slab from the Lapworth Collection for their redescription of this species and the crowded fragments on it show thecae which are much more slender than those of the type specimen in which the thecae are nearer those of *M. involutus*. Lapworth considered that *M. acutus* (Hopkinson 1872) was the same as *M. intermedius* but Hopkinson quite clearly differentiated them. Most later workers have, however, apparently relied on Elles & Wood's account.

TYPE MATERIAL. Holotype, BM(NH) Q.88, Birkhill Shales, Moffat.

REVISED DESCRIPTION. Rhabdosome arcuate, with very slender proximal end, widening from about 0.3 mm. to a maximum of about 1.0 mm. in the distal part. Thecae of the *spiralis* type, the proximal ones with a slender prothecal portion and an abruptly widened apertural region, distal ones more uniformly widening, about ten thecae per cm. The proximal end of the type specimen is poorly preserved but appears to be comparatively straight so that the rhabdosome is not truly spirally



Fig. 5. Sketches of proximal, medial and distal thecae of *Monograptus intermedius*, holotype, Q.88, $\times 10$ approx.

curved in the way shown by *M. communis*, etc. On thecal shape, however, Münch's assignation of the species to *Spirograptus* is quite possible. In general shape and the slender proximal end, the species is close to *Spirograptus planus* (Barrande) as figured by Přibyl (1946, pl. 8, figs. 6-8) but that species rapidly reaches a breadth

of more than 1.5 mm. and the rhabdosome continues to spiral distally. The species is here retained in *Monograptus* sensu lato.

DISTRIBUTION. The type specimen is associated with a proximal end of *M. triangulatus*-type and seems to be from the zone of *M. gregarius*. Most of the records appear to be based on Elles & Wood's description and hence are misidentified so that no distribution can be given at present.

***Diversograptus? capillaris* (Carruthers)**

Fig. 6a, b.

- 1867 *Rastrites capillaris* Carruthers : 368, pl. 2, fig. 10.
 1868 *Rastrites capillaris* Carruthers; Carruthers : 126, pl. 5, fig. 16.
 non 1876a *Rastrites capillaris* Carruthers; Lapworth : 314, pl. 10, fig. 4.
 1876a *Monograptus attenuatus* Hopkinson; Lapworth : 317, pl. 10, fig. 9.
 ?1897 *Monograptus (Rastrites) gemmatus* (Barrande); Perner, t-fig. 26.
 1913 *Monograptus gemmatus* (Barrande); Elles & Wood : 436, pl. 43, figs. 5a-d, ?e.
 1952 *Monograptus* (?subgenus) *capillaris* (Carruthers); Bouček & Přibyl : 206, t-fig. 4d-f.
 1953 *Diversograptus capillaris capillaris* (Carruthers) Bouček & Přibyl : 496, 558, pl. 1, figs. 1-3.

ORIGINAL DESCRIPTION. "Common tube very slender, with short isolated triangular hydrothecae, their base of attachment to the common canal as long or longer than their depth. About sixteen cells to an inch. Loc. Moffat. Richter figures this specimen in *Zeitschr. Deutsch. Geol. Gesellsch.*, V, 1853, Tab. xii, fig. 34a, referring it to *R. gemmatus* Barr., which is very different, and of which his fig. 34b is a good representation".

There has been considerable confusion over this slender species. Carruthers' original description is not clear and Hopkinson (1872) described *M. attenuatus* as another slender species without making detailed comparison with *capillaris*. Lapworth took the generic assignment to *Rastrites* as correct in spite of Carruthers' statement that the base of the triangular theca was longer than its height. From his own larger and more detailed collections from Dobbs Linn, Lapworth (1876a) redescribed *M. attenuatus* and a "*R. capillaris*" which is a true rastritid (see Fig. 6d). Perner (1897) redescribed *M. gemmatus* (Barrande) which has distinctly hooked thecae (Fig. 6c) but while he gave only a natural size figure of the holotype he also gave an enlarged drawing under the same name of a form with simpler thecae. It was apparently this enlarged figure which Elles & Wood took as typical of *M. gemmatus* and accordingly included *M. capillaris* Carr. and *M. attenuatus* Hopkinson in its synonymy. They do not seem to have considered Lapworth's drawings or specimens of "*R. capillaris*" (which are clearly distinct from Carruthers' types) although they refigured his specimens of *M. attenuatus*. Bouček & Přibyl (1952) re-examined the slender monograptids and showed clearly that Carruthers' and Hopkinson's species were distinct from *M. gemmatus*. In the following year they assigned diversograptid forms to *D. capillaris* and the species has been widely recorded as such in Central European work since 1952. Unfortunately British material has so far provided very few examples of diversograptid rhabdosomes while the German material (e.g. Manck 1924) is usually poorly preserved as far as thecal characters

are concerned. It is thus doubtful if the equivalence of the British and Continental specimens can be regarded as proven.

TYPE MATERIAL. Holotype Q.86, from the Birkhill Shales, Moffat.

REVISED DESCRIPTION. Rhabdosome only known as fragments, up to 5 cm. long, very slender, maximum breadth 0.4 mm.; thecae elongate triangular, about seven per cm., widening gradually from the initial prothecal portion, probably with no overlap. Apertures of *spiralis*-type but no spines seen.

DISCUSSION. The type material is very poorly preserved and other slender British specimens are comparatively rare in collections, generally only found as small fragments. It is difficult to match these satisfactorily with the German and Bohemian material which, although more frequently showing complete rhabdosomes, is usually quite flattened and does not show thecal characters well. The slender

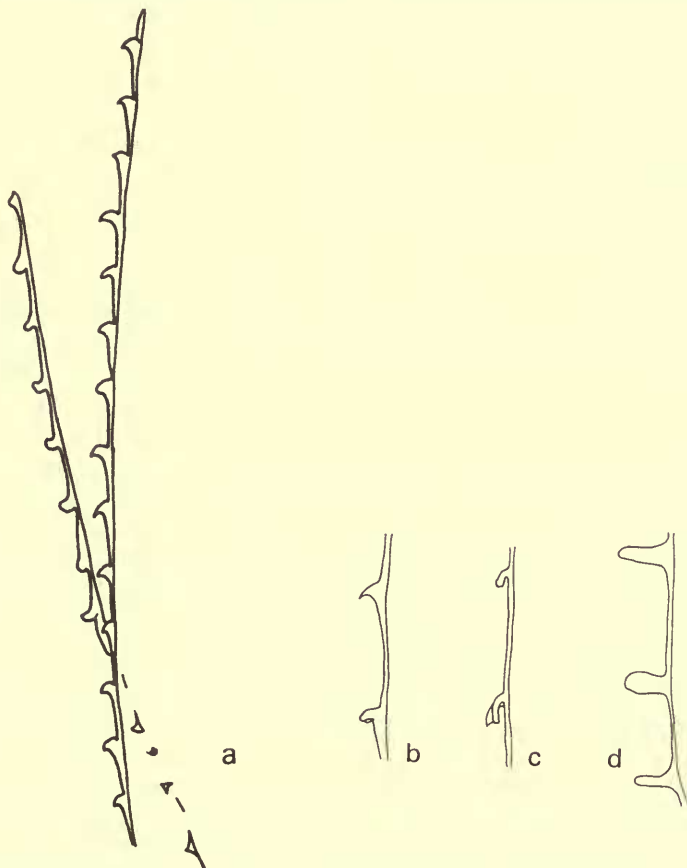


FIG. 6. *Diversograptus? capillaris* Carr. a. Copy from original drawing for Elles & Wood, pl. 43, fig. 5d. Holotype, Q.86. $\times 5$. b. *D? capillaris* Carr. Two thecae for comparison with *M. gemmatus*. Q86. $\times 10$. c. *M. gemmatus* Barr. Fragment of stipe with 2 thecae showing hooked apertures. *R. maximus* Beds, Belcraig Burn, Moffat. BU 304. $\times 10$. d. *Rastrites "capillaris"* Lapw. (? = *R. spina* Richter) Duffkinnell. BU 305. $\times 10$.

stipes appear to have been fairly flexible and the shape of the thecae is variable along the stipe, depending probably on the twisting of the stipe. Although it is quite clear that *D. capillaris* is distinct from *M. gemmatus* (Barrande), its relationship to *M. attenuatus* Hopkinson remains doubtful. The specimens which Lapworth figured as *M. attenuatus* are obviously close to Carruthers' *capillaris* but these may be different from Hopkinson's types which have not yet been traced.

DISTRIBUTION. The type material is associated with *Rastrites* cf. *peregrinus*, indicating a Middle to upper Birkhill age which agrees with the records from the rest of Europe.

Rastrites maximus Carruthers

Pl. 5, fig. 7; Fig. 7a

- 1867a *Rastrites maximus* Carruthers : 540, fig. 90(6)
- 1868 *Rastrites maximus* Carruthers : 126, pl. 5, fig. 14.
- 1876a *Rastrites maximus* Carruthers; Lapworth, pl. 1, fig. 1.
- 1907 *Rastrites maximus* Carruthers; Törnquist : 15, pl. 2, figs. 28, 29, ?27, ?30-33, ?pl. 3, fig. 1.
- 1914 *Rastrites maximus* Carruthers; Elles & Wood : 494, pl. 50, figs. 6a-d, ?6e.
- 1941 *Rastrites maximus* Carruthers; Přibyl : 15.
- ?1955 *Rastrites maximus* Carruthers; Malinowska : 57, pl. 11, fig. 4.
- 1967 *Rastrites maximus* Carruthers; Schauer : 184, pl. 6, fig. 1.

ORIGINAL DESCRIPTION. "Common tube slender, supporting very large hydrothecae at wide intervals. Hydrothecae nearly half an inch long, somewhat enlarged towards the apex, and furnished at the base with a triangular corneous membrane extending a short distance up the margin of the cells. About six cells in an inch. Loc. Moffat."

COMMENTS ON USAGE. This species has been recorded from a few places in Europe but appears to be replaced by *R. linnaei* Barrande in Central Europe. The large rastritids are usually found in a very fragmentary state owing to the extremely slender common canal, and isolated thecae cannot always be identified specifically since the thecal length/interspace ratio appears to be one of the most useful characters for discrimination. All the large forms, however, appear to occur about the same horizon and so are useful for stratigraphic purposes.

Although the species has been widely known and figured by Törnquist (1907) and other authors, no proximal ends appear to have been conclusively demonstrated. Most of the so-called "young specimens" have short, well-spaced thecae which may be broken or represent other species such as *R. distans*. Both Törnquist and Elles & Wood gave measurements for the first few thecae and the interspaces between them but examination of a large number of specimens from the Moffat area and from the Crossfell Inlier, Northern England, shows clearly that the long thecae of the adult develop within the first centimetre much more rapidly than was generally thought. Unfortunately few specimens are found with more than a few proximal thecae and it is difficult to separate *R. maximus* from *R. linnaei* and *R. distans* prior to the four or five theca stage.

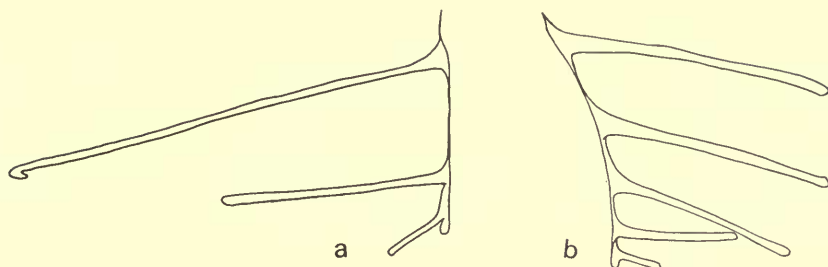


FIG. 7. Proximal ends of *Rastrites* spp. a, *R. maximus* Carr., neotype, BU 1692. b, *R. linnaei* Barr., BU 1700. Both $\times 5$ approx.

Table I gives the dimensions of some of these rhabdosomes but the data are as yet insufficient for a statistical analysis. The positions of theca 1 and th2 are the same in relation to the sicula in the three species, with th2 leaving the common canal at the apex of the sicula.

TABLE I

	length of theca				thecal interspace		
	1	2	3	4	1/2	2/3	3/4
<i>R. maximus</i>							
Törnquist 1907	1.0	2.7	6.2	1.7	1.0	1.4	1.7
Elles & Wood 1913	1.5	3.5	5.0	—	1.5	3.0	—
Neotype, BU 1692	1.4	5.3	10.2	12.0	0.8	3.0	4.5
Q. 1390 BM(NH)	1.1	5.3	10.4	10+	0.8	1.6	4.0
<i>R. linnaei</i>							
BU 1700 (Elles & Wood, pl. 51, fig. 1b)	1.1	3.2	4.8	6.0	0.6	1.1	1.8
<i>R. carnicus</i>							
Seelmeier 1936	1.2	—	5.0	—	(0.1—0.3)		

TYPE MATERIAL. Carruthers' type specimen cannot be traced in the British Museum (Natural History) collections and although Q. 1390 bears some resemblance to Carruthers' figure there are no details of locality or horizon for it. Accordingly a neotype is here proposed, chosen from the specimens figured by Elles & Wood. The specimen, B.U.1692 (Elles & Wood, pl. 50, fig. 6b) is from the Upper Birkhill Shales of Riskinhope Burn, Yarrow, Peeblesshire. (For stratigraphic details see Lapworth 1878 : 272).

REVISED DESCRIPTION. Adult thecae more than 10 mm. long (maximum observed 1.8 cm.) with interspaces about 5 mm; common canal very slender; base of theca characteristically enlarged with the proximal side at right angles to the common canal and the distal side somewhat oblique. Thecal apertures with a well-defined hook.

DISTRIBUTION. The species is known from many localities in the Moffat area and was recorded by Elles & Wood from the Lake District and North Wales.

Records from Sweden and Central Europe are doubtful although, as noted above, it is often impossible to determine specifically the fragmentary large rastritids. Amongst the Bohemian material in the Lapworth Collection there are no specimens approaching the typical form in length and spacing of the adult thecae. Recent records from Belgium (Legrand 1962) and Portugal (Romariz 1962) give no illustrations or dimensions and require confirmation. The specimen figured by Malinowska (1955) has a broad common canal although the thecae appear to be long enough. Schauer (1967) has figured a good specimen from Germany.

Cyrtograptus murchisoni Carruthers

Pl. 5, fig. 8, 9; Fig. 8

- 1867a *Cyrtograptus Murchisonii* Carruthers : 540, foss. 90, fig. 1.
 1868 *Cyrtograptus Murchisonii* Carruthers; Carruthers : 128, pl. 5, figs. 17a, b.
 ?1899 *Cyrtograptus Murchisoni* Carruthers; Perner : 21, t-fig. 28.
 1900 *Cyrtograptus Murchisoni* Carruthers; Elles, pl. 24, fig. 6.
 1914 *Cyrtograptus Murchisoni* Carruthers; Elles & Wood : 505, pl. 51, figs. 3a-c.
 ?1933 *Cyrtograptus murchisoni* Carruthers; Bouček : 30, pl. 2, figs. 1-3.
 non 1939 *Cyrtograptus murchisoni* Carruthers; Chang & Sun, pl. 1, figs. 4-8.

ORIGINAL DESCRIPTION. "Hydrothecae triangular apiculate, furnished with a spine. The upper margin of the cell at right angles to the axis, about twenty-eight cells to the inch. The polypary is considerably incurved at its proximal end, and as it grows it gradually opens into a larger curve. The branches spring from the celluliferous surface of the polypary, but as there is no break in the continuity of the hydrothecae, they must arise from the periderm covering the common canal. The branches also curve in the same direction as the main portion of the polypary. Loc. Pencerrig, Builth. I have associated the name of the author of 'Siluria' with this remarkable species. The only British specimens I have seen are in the Geological Museum, Jermyn Street, but among the specimens obtained by the British Museum from M. Barrande there is a specimen from Listice, labelled *G. priodon*, which belongs to this species."

COMMENTS ON USAGE. Carruthers' figure is somewhat idealized but there is no difficulty in recognizing the species. The syntypes are not well preserved and do not show the proximal end well on the large specimens although this may be the result of damage to the specimens which have at some stage been broken. This is unfortunate as Bouček, in his revision of the *Cyrtograptidae* (1933), distinguished forms with excentric proximal coiling from those with central (and more open) coiling. He had no forms of the first type with secondary branches (a characteristic of *murchisoni*) but he separated the simply-branched forms (*centrifugus* and *murchisoni bohemicus*) on the proximal ends. The type slabs of *murchisoni*, however, show proximal curvature of the *centrifugus* type and this was also figured by Elles & Wood.

It is reasonable to separate the simply-branched forms as a subspecies as there appears to be some stratigraphic value in this (see Rickards 1965) but if the curvature is also admitted as a diagnostic character, a new name is required for the Bohemian

specimens of "*murchisoni*". If the proximal end is regarded as a variable feature within the species, then there is no good criterion for separating *centrifugus* from *m. bohemicus* and these may both be regarded as junior synonyms of Tullberg's *C. murchisoni* var. *crassiusculus*. Pending a revision with full stratigraphic details of these Lower Wenlock cyrtograptids, it seems best to restrict the present account to the redescription of Carruthers' syntypes and the numerous topotypes.

TYPE MATERIAL. Carruthers noted that his types were in the Jermyn Street Museum and the specimen and counterpart are now numbered GSM 10717-8. They are from the Wenlock Shale, Pencerraig, Bulth, Radnorshire.

REVISED DESCRIPTION. Rhabdosome stout, proximal end forming a helical spiral with triangular thecae of the *spiralis* type. First-order cladia curved, arising at well-spaced intervals (about five to eight thecae between each) and bearing secondary branches which are generally curved in the same direction. Thecae on the distal part of the main stipe and on the cladia have a tubular proximal part and a short, hooked aperture. The change takes place on the main stipe after the third or fourth cladium. Thecae ten to fourteen per cm.

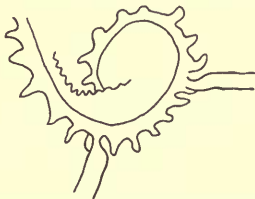


FIG. 8. *Cyrtograptus murchisoni* Carr. Poorly preserved proximal end showing excentric coiling. The most proximal thecae are underneath the later part of the main stipe. GSM 10717. $\times 3$.

DISTRIBUTION. As noted above, there is some difficulty in matching Bouček's description of the Bohemian material with the British types, although Carruthers recognized the species in material from Listice. The stout, secondarily branched forms appear near the base of the Wenlock throughout Europe and it appears convenient to regard them all as one species. Further geographic variation may be noticed when well-preserved material from other areas is studied. The species has been recorded from Canada but so far without confirmatory illustrations. The form recorded from China appears to be the earlier species, *Monograptus spiralis*. Russian records (Obut 1964; Obut, Sobolevskaya & Bondarev 1965) appear to be of the species group but not the typical form. The relationship of *C. murchisoni* to the forms with only first order branches is still unknown but the latter seem slightly earlier stratigraphically (Rickards 1965) and could well be ancestral. The absence of cyrtograptids from the succeeding zone of *M. riccartonensis* suggests that the later *C. rigidus* and its allies are not phylogenetically related to *C. murchisoni*, since this would involve a reversal of the trend towards more numerous branches.

In my notes on British zones (Strachan 1960) I observed that *C. murchisoni* was "apparently unknown outside the type locality". Since then I have seen many-branched specimens from the Wenlock of the South of Scotland and Rickards (1965) has also found numerous specimens in the Lake District.

Dendrograptus lentus Carruthers

1867a *Dendrograptus lentus* Carruthers: 541, foss. 90, fig. 5.

1868 *Dendrograptus lentus* Carruthers: 130, pl. 5, fig. 5.

The specimen described under this name is preserved in the Geological Survey & Museum, GSM 10691 (and counterpart 10692). The species was noted by Wood (*in* Elles & Wood, p. lvii) as belonging to *Clonograptus* and a note on the specimens says "Shinerton Shales, Shrops." Carruthers recorded the species as "Caradoc, Co. Fermanagh" and the specimens are listed as such in the Survey Catalogue of 1878. However there is a collection number with the drawing of this species in Carruthers' notes and this appears in the Survey Catalogue of 1864 as "*Graptolithus* sp. Cambrian, Wrekin." There thus is some confusion over this species and since the name has not been used, so far as I can ascertain, since the original descriptions it is best regarded as a *nomen dubium*, and an appropriate recommendation to the ICZN has been made. If the species were to be regarded as valid, the name *lentus* would have priority over the widely used name *tenellus*, and these fragments are too poor to be the basis of this well-known species.

III. REFERENCES

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